Less sensitive proton-exchange membrane to a relative humidity below 30%

Abstract

In this work, we focus on a novel sepiolite-incorporated Aquivion composite membrane that can be operated in a proton-exchange membrane fuel cell (PEMFC) at a relative humidity (RH) below 30%. The maximum power density reduction of the developed membrane is only 0.77% at 30% RH. In the study, we demonstrated adding sepiolite grafted with fluorination groups enhanced the homogeneity of the composite membrane prepared with Aquivion compared to composite membranes prepared with natural sepiolite. In addition to functionalization, a specific acidic post-treatment enhanced fuel cell performance. The acidic treatment was intended to remove some of the Fe cations in the sepiolite to prevent Aquivion degradation. Although this effect was not evident, this treatment removed some of the Al and Mg cations, resulting in a more amorphous structure of fluorinated sepiolite with increased porosity, roughness, and lumen. This significantly enhanced the proton diffusion in the composite membranes. Compared to commercially available membranes and membranes developed by other research groups, the Aquivion/fluorinated and post-treated sepiolite composite membranes (Aq/pSEP-F5) exhibited increased swelling behavior, water uptake, mechanical property, chemical stability, proton conductivity, cell voltage, and maximum power density in the Membrane Electrode Assembly (MEA). Thus, they are highly advantageous and a promising alternative for the functioning of PEMFC at low relative humidity.